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(54) (Invention Name) Steering Operational Device

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Specifications

1. Name of Invention

Steering Operational Device

2. Range of Patent Claims

A steering operational device that contains a steering wheel which allows the direction of the object of the steering operation to be altered;

and that contains a motor to rotate or shake the aforementioned steering wheel;

and that contains an encoder that detects the amount of rotation or the amount of shaking of the aforementioned steering wheel;

and that contains a driver control circuit that detects the aforementioned amount of rotation and amount of shaking which corresponds to the detection results of the aforementioned encoder.

3. Detailed Explanation of the Invention

[Industrial Field of Usage]

This invention is related to steering operational devices, particularly those steering operational devices suited for driving game machines.

[Prior Technology]

Amongst prior steering operational devices of this type, there are known devices that simulate the reaction of a road's surface upon the steering operational device.

For example, such known devices include (Japanese Unexamined Utility Model Application Publication No. S63–71088) in which the motor axle and [illegible] center arm are joined together, and vibrations are produced when the motor is rotated, and (Japanese Unexamined Utility Model Application Publication No. H1–165090) in which a brake is affixed to the steering shaft so that it is possible to impose a load upon the steering operations.

Further, other known devices include (Patent Report No. S48-18279) which gives a shock using solenoids, (Patent Report No. S51–32507) which utilizes [illegible] to return to the center position, and (Patent Report No. S63–160891) which uses a motor to rotate the [illegible] and to produce vibrations.

[Problems Attempted to be Solved by this Invention]

In each of the prior steering operational devices indicated above, there is an insufficient

feeling of [illegible], since they substitute reactions to the road surface with such simple movements as vibrations and shocks.

In particular, when simulating the steering operational devices of a vehicle running on a dirt course, there have been no steering operational devices that reproduce the size of the kick-back (reactions from the road surface) caused by the size of bumps in the road surface.

This invention solves the aforementioned problematic points, and attempts to reproduce reactions from the road surface in a realistic manner.

[Means of Solving Problems]

In order to achieve this goal, the steering operational device of this invention is constructed so that it contains a steering wheel which allows the direction of the object of the steering operation to be altered; a motor to rotate or shake the aforementioned steering wheel; an encoder that detects the amount of rotation or the amount of shaking of the aforementioned steering wheel; and a driver control circuit that detects the aforementioned amount of rotation and amount of shaking which corresponds to the detection results of the aforementioned encoder.

[Operation]

In the aforementioned steering operational device, the motor rotates or vibrates the handle with an appropriate degree of power as if reacting to the road surface, in correspondence with the drive direction and amount of drive detected by the driver control circuit. This produces a realistic effect of the reaction felt from the road surface.

[Examples of Embodiment]

The following section utilizes diagrams to explain the example of embodiment of this invention.

Figure 1 is a block diagram that indicates an example of embodiment of the steering operational device contained in this invention. Figure 2 is a diagrammatic view of the

exterior of a driving game machine that utilizes the steering operational device contained in this invention.

In Figure 1, the image signal is supplied from main circuit 2 in response to the advancement conditions of the driving game on monitor 1 (refer to Figure 2). Main circuit 2 is a circuit that consists in total of a driving game which detects the operational conditions of coin insertion device 3 indicated in Figure 2, as well as shift lever 4, axle pedal 5, and brake pedal 6.

The [illegible] distance signal and the positional signal in relation to competitive players (or enemies) (the x-axis in Figure 4) is supplied from main circuit 2 to CPU circuit 8, in response to the operational conditions of shift lever 4, axle pedal 5, and brake pedal 6. As explained below, CPU circuit 8 runs according to a program recorded in ROM 9 to produce a motor drive signal. The motor drive signal produced by CPU circuit 8 is converted to a drive signal by motor drive circuit 11, and is supplied to DC servo motor 12.

On rotation axis 12a in DC servo motor 12, a rotary encoder 13 is affixed to the [illegible] end portion of DC servo motor 12. The rotation quantity of rotation axis 12a is encoded, and transferred to motor drive circuit 11. Motor drive circuit 11 utilizes the output from rotary encoder 13 as a servo signal, and also supplies this to CPU circuit 8 as a signal (the y-axis in Figure 4) that indicates the current location of the vehicle being driven (player vehicle 30 in Figure 4).

The DC servo motor 12 and rotary encoder 13 positioned on that axis drives the steering wheel 14 as indicated in Figure 3, and further is revolved by means of the steering wheel 14.

The steering wheel 14 is affixed to the handle shaft 17 by means of a bolt 18, together with the handle block 15 and vos [sic] cover 16. Handle shaft 17 passes through passage holes 7a and 19a that are located on the dashboard panel 7 and control panel 19, and is inserted

and fixed into the rotating area of bearing 20. This [illegible] is conducted by tightening nut 22 across spacer 21 onto screw 17a from the handle shaft 17.

Further, there is a key groove 17b affixed to the tip of handle shaft 17. By tightening this key groove 17b and key groove 24b on pulley 24, the pulley 24 is affixed to the handle shaft 17. Moreover, axis movement in the direction of pulley 24 is prevented by C ring 25.

The aforementioned bearing 20 is equipped on base bracket 28, and DC servo motor 12 and rotary encoder 13 are affixed to this base bracket 28.

A pulley 27 is attached to the rotating axis 12a of DC servo motor 12, and a belt 26 is wrapped between this pulley 27 and pulley 24. By means of this belt 26, the DC servo motor 12 and rotary encoder 13 vibrate the steering wheel 14, and furthermore, driving may be performed using this steering wheel 14.

In the following section, movement will be explained with reference to Figures 4 through 6.

Figure 4 (a) and (b) indicates the passage that is displayed on monitor 1 (in Figure 1 and Figure 2) when the player's vehicle that is controlled by driving is faced with a rock obstruction 31. When the player's vehicle 30 advances in the advancement direction (direction X) as indicated in Figure 4 (a), the right front axle hits the rock 31 as indicated in Figure 4 (b). The position (coordinates) and size of the rock 31 is previously memorized by ROM 9 in the same manner as the program.

As for the advancement position (X coordinate) of player vehicle 30, the positional signal of the [illegible] and competitive players (or enemies) are supplied from the main circuit 2 to the CPU circuit 8, in response to the operational conditions of shift lever 4, axle pedal 5 and brake pedal 6. Output from the rotary encoder 13 that is supplied to CPU circuit 8 is used as the signal that indicates player vehicle 30's position in relation to the road surface (Y coordinate) and the current position of player vehicle 30. By reading from ROM 9 the

height of the rock 31 that is stored in the address of ROM 9 as appropriate to the coordinates (X, Y) at a given time, it is possible to calculate the height position of the left and right front axle.

In Figure 4 (b), the right front axle of player vehicle 30 has hit rock 31. Therefore, the right front axle of player vehicle 30 becomes higher than the left front axle. CPU circuit 8 calculates this and when the height difference between the left and right front axles is large, a motor drive signal is produced that greatly rotates in the clockwise direction. Due to this signal, the steering wheel 14 is greatly driven in the clockwise direction by the DC servo motor 12. This movement allows the game player to enjoy the [illegible] as the steering wheel 14 is returned in the clockwise direction.

Figure 5 (a) indicates a situation in which a competitive player (or enemy) has crashed in from the left direction. In this case, the DC servo motor 12 drives the steering wheel 14 in the clockwise direction, in response to the size of the impact. The size of the impact from the crash is proportionate to the height of rock 31 in Figure 4. Further, Figure 5 (b) indicates a situation in which a competing player (or enemy) has crashed in from the front. In this case, the DC servo motor 12 drives the steering wheel 14 both left and right.

Figure 6 summarizes the aforementioned movements in a flowchart of CPU circuit 8. According to Figure 6, the game is started, and it is judged whether or not an obstacle is hit (step 33) or an enemy vehicle is hit (step 34). Depending on the height difference between the right and left front axles, the drive direction and drive volume (reaction volume) of the steering wheel 14 is determined (step 36). It is then calculated which direction an enemy vehicle came from and how hard the strength of crash impact has been incurred (step 37). The results of the calculation are supplied to motor drive circuit 11 (step 38).

In addition to the aforementioned steps in Figure 6, it is determined whether or not the road is bad (step 35), and if an obstacle is a river or mud, etc.. The drive direction and drive volume (reaction volume) of the steering wheel 14 is then calculated.

The example of embodiment of this invention has been explained in the preceding paragraphs. However, due to the technological concepts in this invention, numerous variations are possible.

For example, the aforementioned example of embodiment was explained using a car as the vehicle to be driven, but it is also possible to simulate the steering operational device of a motor boat or airplane. In this case, the drive direction and drive volume (reaction volume) of the steering wheel 14 are calculated according to the speed of the motor boat or airplane, as well as to the water or wind viscosity resistance, etc..

Further, it is also possible to make the steering wheel 14 into a handle bar such as that used on motorcycles and bicycles. In this case, the DC servo motor 12 would vibrate the handle bar through rotation.

Moreover, the circumstances have been explained whereby the DC servo motor 12 and rotary encoder 13 have been positioned on the same axle, but it is also possible to separate them. For example, it is possible to position only the rotary encoder 13 close to the steering wheel 14.

[Effects of the Invention]

As indicated above, the steering operational device contained in this invention is constructed so that it contains steering wheel which allows the direction of the object of the steering operation to be altered; a motor to rotate or shakes the aforementioned steering wheel; an encoder that detects the amount of rotation or the amount of shaking of the aforementioned steering wheel; and a driver control circuit that detects the aforementioned amount of rotation and amount of shaking which corresponds to the detection results of the aforementioned encoder. Therefore, the motor rotates or vibrates the steering wheel with sufficient force as to simulate the reaction to an obstacle, in correspondence to the drive direction and drive volume detected by the driver control circuit. This makes it possible to

reproduce reactions from the road surface in a realistic manner.

4. Simple Explanation of Diagrams

Figure 1 is a block diagram that indicates an example of embodiment of the steering operational device contained in this invention.

Figure 2 is a diagrammatic view of a driving game machine that utilizes the steering operational device contained in this invention.

Figure 3 is a cross-sectional diagram that indicates an example of embodiment of the steering operational device contained in this invention.

Figure 4 is a conceptual diagram that explains the movement that occurs in the example of embodiment of the steering operational device contained in this invention.

Figure 5 is a conceptual diagram that explains the movement that occurs in the example of embodiment of the steering operational device contained in this invention.

Figure 6 is a flow chart that explains the movement that occurs in the example of embodiment of the steering operational device contained in this invention.

11	Motor drive circuit
12	DC servo motor
13	Rotary encoder
14	Steering wheel
24	Pulley
26	Belt
27	Pulley

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Figure 1

1	Motor

2 Main circuit

8 CPU circuit

11 Motor drive circuit

Figure 2

Figure 3

Figure 4

(a)

31 Rock

Direction of advancement

Position

(b)

31 Rock

Figure 5

(a) When enemy hits from side

(b) When enemy hits from front

Wheel vibration

Figure 6

Game starts

33	Hit an obstacle	Yes	No
34	Hit an enemy vehicle	Yes	No
35	Bad road	Yes	No

36 Check height of right and left tires and determine turn direction

37 Check whether or not vehicle is hit from the side

38 Check whether a river or mud, etc., and establish the appropriate movement

39 Transmit to motor drive circuit